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**CONTROL**  
*of*

**INSECTS ATTACKING  
STORED**

**POPCORN**



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# CONTROL OF INSECTS ATTACKING STORED POPCORN

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Investigations

Popcorn, like ordinary corn, may be infested with insects while in storage. Since it is used entirely as a human food, it must be kept free from insects. Furthermore, the higher prices obtained for popcorn than for ordinary corn intended for animal feed warrant the expenditure of more money and effort to keep it in condition.

## Sources of Infestation

Popcorn grown in the Northern States is not infested in the field to any appreciable extent, and the few insects that are carried into the cribs with the ears usually are killed by the low winter temperatures. In the southern portion of Ohio, Indiana, Missouri, and Kansas and in States farther south, popcorn may become severely infested by the Angoumois grain moth and the rice weevil before it is taken from the field, and with the arrival of warm weather the following spring it may be seriously damaged while in storage unless the proper precautions are taken. Even in the North popcorn in crib storage may become infested with insects from nearby sources.

After popcorn is shelled and put in warehouse storage or shipped to the trade, it is also likely to become infested by the many insect pests that attack stored grains. Probably the worst of these pests is the Indian-meal moth. This insect is prevalent wherever foodstuffs are stored. The caterpillars feed on the germ of the corn and web the kernels together. They spin their silken webs over infested bags and create unsightly conditions.

### Preventive Measures

As soon as corn is dry enough for safe storage in tight bins, it should be shelled and placed in such bins to reduce the danger of infestation from migrating insects.

Good housekeeping around storage bins and in the warehouse is one of the best methods of preventing trouble from insects. Loose grain, stock feed, and floury materials serve as breeding places. Cribs, bins, warehouses, and surrounding premises should be kept thoroughly clean of such materials. Stored-grain insects will not breed on premises that are free from such materials.

Corn that has become infested in the field should be fumigated in the cribs as soon as possible after harvest.

The packaging of popcorn in moistureproof containers, such as tin cans or hermetically sealed fiberboard tubes, protects the corn not only from moisture loss but also from invasion

by most insects. The cadelle is capable of cutting through fiberboard, but it is not usually abundant enough to be an important pest of packaged popcorn. It is desirable to fumigate all popcorn before it is packaged in these containers.

### Fumigation of Popcorn

When popcorn in storage becomes infested with insects, the quickest and most effective method of destroying the infestation is to fumigate the corn. When properly applied, fumigants will kill all stages of insects inside or outside the kernels of corn.

Cribbed Corn.--For fumigation in the cribs they should be lined with roofing paper, fiber-reinforced paper, or other material to make them tight enough for fumigation. They should also be provided with ventilators to facilitate drying after the fumigation.

Fumigants recommended are carbon tetrachloride, a 4:1 mixture of carbon tetrachloride and carbon disulfide, a 3:1 mixture of ethylene dichloride and carbon tetrachloride, or any of these fumigants to which has been added 5 percent by volume of ethylene dibromide. The dosage required will vary with the tightness of the crib. In wooden cribs 6 gallons of any of these fumigants is recommended per 1,000 bushels.

When perforated steel cribs are used, the entire crib can be covered with rubberized or plasticized tarpaulins, or with a combination of such



tarpaulins and fiber-reinforced paper. These cribs can also be wrapped with sheets of plastic material to make them tight enough for fumigation.

For the treatment of perforated steel cribs, methyl bromide is recommended at the rate of 2 pounds per 1,000 cubic feet of space.

Corn in Bins. -- For the treatment of popcorn in ordinary storage bins, any of the common grain fumigants can be used. The carbon tetrachloride mixtures recommended for crib fumigation are suitable. The bins should be made as nearly gastight as possible. Metal bins or bins lined with galvanized sheet iron are preferable, but wooden bins can be used if they are lined with felt building paper or fiber-reinforced waterproof paper. It is helpful, though not necessary, to cover the top surface of the corn with a tarpaulin.

In tight metal bins or bins that have been lined with sheet iron, the dosage recommended for crib fumigation may be reduced by 20 percent. The fumigant should be applied uniformly over the surface of the corn with a bucket pump or other type of sprayer. The fumes are dangerous; therefore, the operator should not enter the bin to apply the fumigant.

Warehouses. -- Warehouse stocks can be treated by fumigating the entire warehouse if the building is tight enough to retain the fumigant. For this purpose methyl bromide may be used at the rate of 1 1/2 pounds or hydrocyanic acid at 1 pound per 1,000

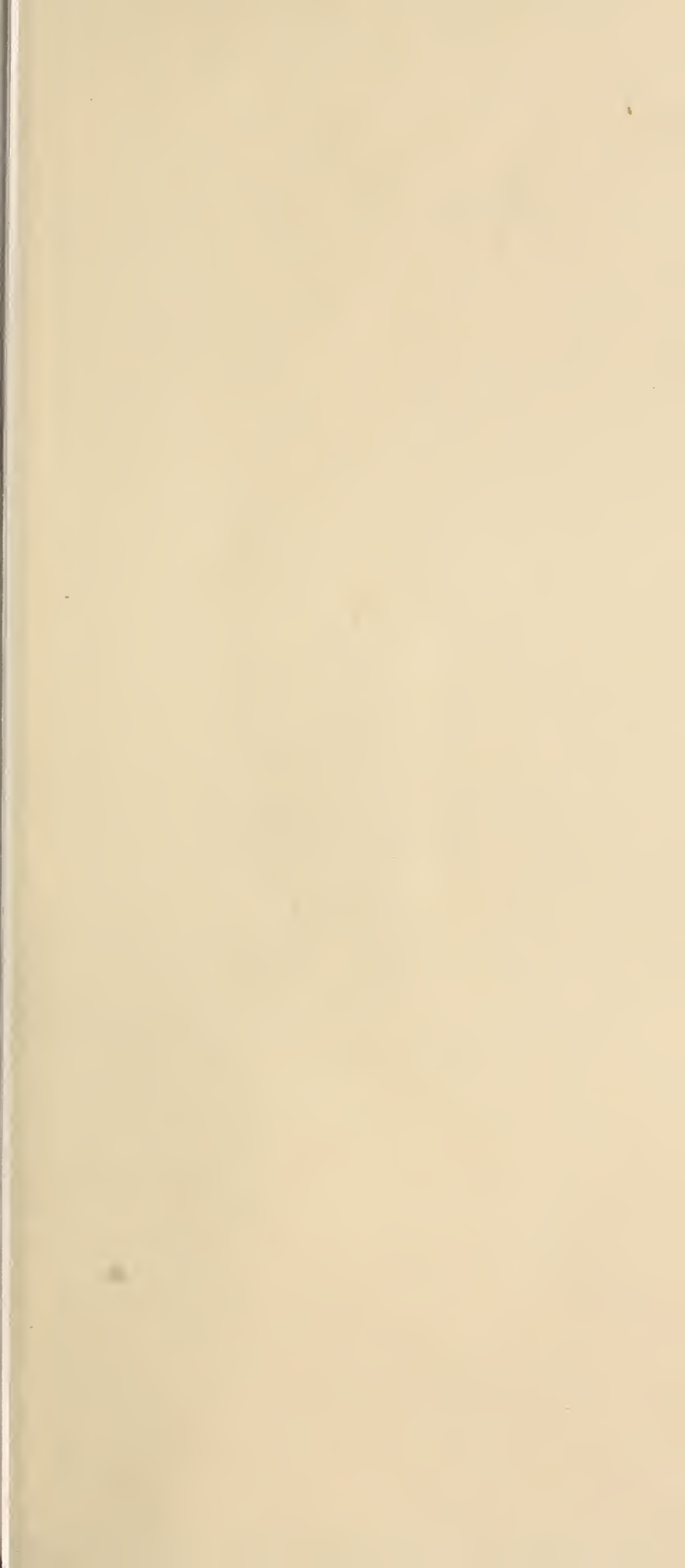
cubic feet of space. The building should be tightly sealed and should be kept closed for at least 24 hours after the fumigant has been applied. For best results the temperature should be above 75° F. during fumigation.

If a warehouse is not tight enough for successful fumigation, the popcorn can be fumigated in gastight chambers or under rubberized or plasticized tarpaulins. The fumigant, dosage, and exposure period should be the same as for warehouse fumigation.

Fumigation Before Packaging. -- For fumigating popcorn before it is packed in cans or bags, it is placed in metal packer bins that have been equipped with external ducts and a fan for the circulation of air or fumigant through them. Methyl bromide is introduced just in front of the fan, which blows the mixture of air and fumigant into the top of the bin and circulates it through the popcorn. The circulation should be continued for 15 or 20 minutes to distribute the vapors uniformly through the bin. All outlets are kept closed to hold the gas in the bin for 15 to 24 hours. Fresh air is then circulated through the bin and the fumigant discharged through a pipe to the outside of the building.

If the temperature of the corn is 70° F. or above, 1 1/2 pounds of methyl bromide per 1,000 cubic feet should be used. For colder corn the dosage must be increased until at 40°, the lowest temperature at which the corn can be successfully fumigated, 3 pounds per 1,000 cubic feet should be used.





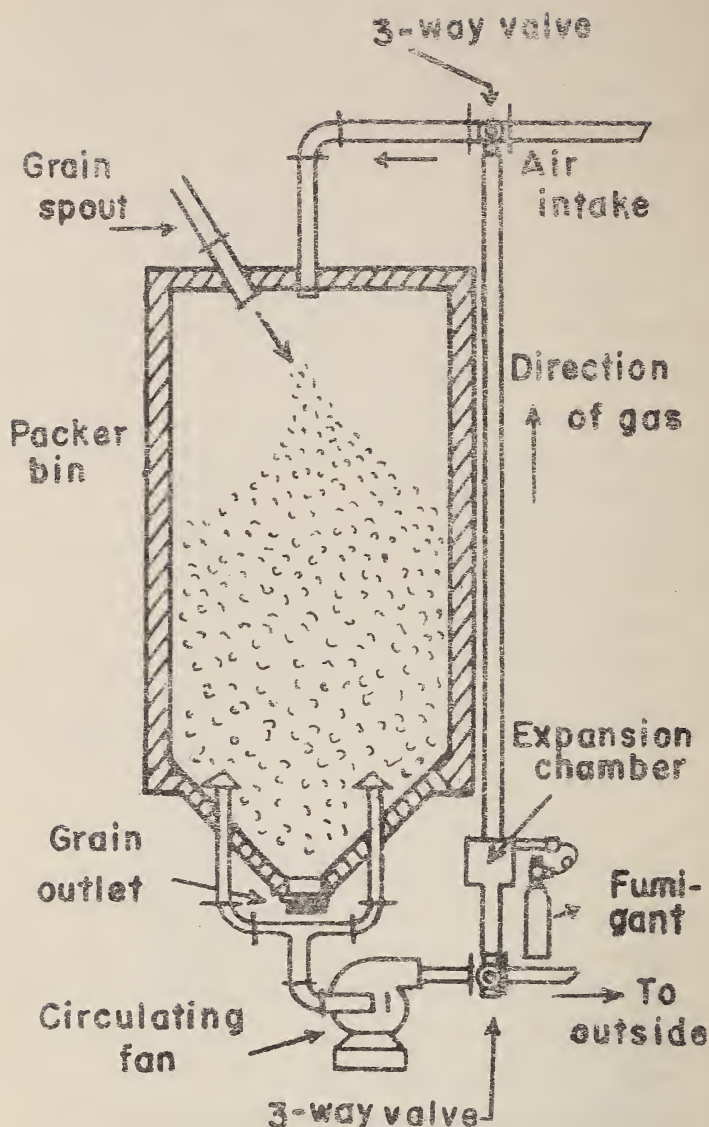


Diagram of packer bin with equipment for circulating fumigant or air through popcorn.

Popcorn in Railway Cars.--It may at times be desirable to fumigate bagged popcorn in the railway cars in which it is to be shipped. In tight steel cars a dosage of 10 pounds of methyl bromide per car is recommended; in wooden cars the dosage should be increased to 14 pounds. Refrigerator

cars containing shelled popcorn may be fumigated by introducing 8 pounds of methyl bromide through the ice compartments at each end of the car. The cars should be carefully sealed and held on the tracks for 24 hours before shipping.

Small Lots of Popcorn. --For the treatment of small lots of popcorn, 100-pound metal cans or similar tight containers can be used. One ounce of any of the fumigants suggested for use in treating corn in cribs should be used for each container. The fumigant can be poured on a piece of cloth or cotton wad, placed on top of the corn, and the lid sealed with scotch tape or masking tape for 24 hours.

### Caution

Chemicals used in grain fumigation are poisonous to human beings and animals. So be careful! Avoid breathing the vapor or spilling the fumigant on the skin or clothing. Clothing wet with the fumigant should be removed at once and the skin washed with soap and water. Warehouse, vault, and tarpaulin fumigation should be done only by experienced fumigators, who are familiar with the hazards and municipal regulations connected with the work.

Workers who are likely to be exposed to the fumes should wear full-facepiece gas masks equipped with canisters approved by the United States Bureau of Mines for protection against the fumigants recommended herein.

For use with hydrocyanic acid a white canister designed to protect against acid gases should be used. For the other fumigants a black canister designed to protect against organic vapors should be used. The effective life of a gas-mask canister is limited. It should therefore be replaced by a fresh one after 30 minutes of continuous or intermittent exposure to grain fumigants, and the length of such exposure should be recorded on the canister.

### Effect of Fumigation on Quality

All fumigants have some effect on the popping quality of corn. Most fumigants cause a reduction in the volume of popped corn, but the effect is only temporary and disappears after aeration. Hydrocyanic acid differs from other fumigants in that it improves the popping quality of the corn, the volume of the popped corn being greater than the untreated corn. This effect does not last more than 10 days. None of the fumigants recommended in this circular will stain or discolor the corn.

### Cold Storage

The insect pests of stored corn do not lay eggs at temperatures below 60° F. and are inactive below 45°. Storage at 40° to 45° will prevent insects from injuring the popcorn, but they can survive long exposures to these temperatures. To obtain a quick kill the popcorn should be exposed to a temperature of 0° for about 24 hours.

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